

PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Devices for Measuring Liquid Flow

5 We, PHILIPS ELECTRICAL INDUSTRIES LIMITED, of Spencer House, South Place, Finsbury, London, E.C.2, a British Company, do hereby declare the invention, for which we

10 pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—
It is known to measure by electrical means

15 the speed of flow of an electrically conductive or semi-conductive liquid in a pipe by utilizing the phenomenon that when an electric conductor moves in a magnetic field, an electromotive force is induced therein, the
20 value of which is proportional to the speed of movement of the conductor.
In known devices based on this principle the liquid flows through a pipe placed in a homo-

25 geneous magnetic field, so that its axis is at right angles to the lines of force of the field. Two electrodes are arranged diametrically opposite in the wall of the pipe at right angles to the lines of force. Due to the flow of the liquid a voltage is induced between said electrodes which is substantially proportional to
30 the speed of flow of the liquid. This voltage is measured and serves as an indication of the liquid flow speed.
In order to avoid the influence of polarization of the electrodes, it is known to utilize an alternating magnetic field instead of a uni-
35 directional magnetic field. In this case it is necessary to take particular steps for compensating the electromotive force induced in the measuring circuit, by means of a trans-
40 former which compensates for the electromotive force induced in the measuring circuit by the alternating field, under conditions of zero liquid flow. However, an advantage is that the voltage produced as a result of the liquid
45 flow is an alternating voltage, which may be amplified in a simpler way than a direct voltage. The amplified voltage after being rectified is measured by means of a direct current meter. The alternating magnetic field is produced in a laminated magnetic circuit including an energizing coil traversed by an alternat-

ing current which may be taken from the mains.

In known devices based on the principle described, the pipe usually has a circular cross-section, the liquid flow in this case must have rotational symmetry. The last-mentioned requirement is not always fulfilled in practice, so that in certain cases the measurement is
50 inaccurate.

The object of the present invention is to provide a device, which permits of obtaining more accurate measurement, even if the cross-section of the pipe is not circular.

55 Use is made of a device of the kind above described. The invention consists in that the field has a bi-polar rotational field and a plurality of pairs of electrodes are arranged in the pipe.

60 The rotating field may be produced in a known manner by means of two or more windings arranged along the periphery of the pipe in relatively shifted positions, said windings being traversed by currents having a suitably chosen phase different with respect to one another. The magnetic circuit in this case is preferably laminated. Instead thereof, a rotating magnetic field may be produced by means of a permanent magnet set into rotation. The
65 magnet may be a known ferro-magnetic compound permanently magnetized and having a high coercive force, which compound is substantially non-conductive.

70 The voltages set up across the pairs of electrodes, after being amplified, may be rectified and the rectified voltages joined together to a measuring instrument.

75 Each pair of electrodes are disposed symmetrically with respect to a line of symmetry through the centre of the liquid flow in the pipe. In many cases, for example for pipes having a non-circular cross-section, it is preferable to position the electrodes in a different manner. The speeds of flow of the liquid are
80 different at the various pairs of electrodes. It is usually desired to measure the total amount of liquid flowing through the pipe per second. In order to ensure that the indication of the

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measuring instrument is substantially dependent only upon this, it is desirable that variable resistors should be included in the various measuring circuits, by means of which the output voltages of the various measuring circuits may be controlled by hand.

In order that the invention may be readily carried into effect, one embodiment of this invention will now be described, by way of example, with reference to the accompanying diagrammatic drawing.

A pipe 1, which is traversed by electrically conductive or semi-conductive liquid, is assumed to have a non-circular cross-section. Its wall consists of non-conductive material. By means of a magnetic system 2, on which energizing windings may be arranged, or which may comprise a rotary permanent magnet, a bi-polar, preferably homogeneous magnetic rotating field is produced at the area, at which the speed of the flowing liquid is to be measured. The course of the lines of force thereof at a given moment is indicated by dotted lines 3. A plurality of pairs of electrodes 4—5, 6—7, and 8—9 are provided in the line. Between each pair of electrodes an alternating voltage is produced as a result of the liquid flow at this area, the frequency of this voltage being determined by the rotational speed of the field and its amplitude being dependent upon the speed of flow and the strength of the field, but independent of the rotational speed thereof. During the measurement, the voltage is determined, which is dependent upon all the electromotive forces introduced between the pairs of electrodes.

For this purpose, the pairs of electrodes are connected to amplifiers 10, 11, 12 the output voltages of which are applied via trans-

formers 13, 14, 15 to rectifiers 19, 20, 21 in Graetz connection. The output voltages act in series upon an indicating instrument 22. Resistors 16, 17, 18 serve to enable the output voltages to be marched to the liquid flows at the associated pairs of electrodes, so that the indication of the meter 22 under any conditions gives an indication of the total amount of liquid flowing through the pipe per unit-time.

WHAT WE CLAIM IS:—

1. A device for measuring liquid flow comprising a pipe traversed by a liquid and members for producing a preferably homogeneous variable magnetic field at right angles to the axis of the pipe and comprising means for measuring the electromotive force produced in the magnetic field between two electrodes arranged in the pipe as a result of the movement of the liquid, characterised in that the field is a bi-polar rotational field and at least one further pair of electrodes is provided in the pipe, the electrodes of any pair being disposed symmetrically with respect to a line of symmetry through the centre of the liquid flow and the rectified voltages all being introduced in the circuit of a measuring instrument.

2. A device as claimed in claim 1, characterised in that variable resistors are included in the circuits of the rectifiers.

3. A device for measuring liquid flows, as claimed in claim 1, arranged substantially as herein described with reference to the accompanying diagrammatic drawing.

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This drawing is a reproduction of
the Original on a reduced scale.

